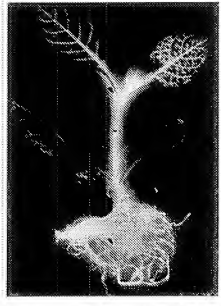
Genetic engineering

From Wikipedia, the free encyclopedia

Genetic engineering, **genetic modification (GM)** and **gene splicing** are terms for the process of manipulating genes, generally implying that the process is outside the organism's natural reproductive process.

It involves the isolation, manipulation and reintroduction of DNA into cells or model organisms, usually to express a protein. The aim is to introduce new characteristics or attributes physiologically or physically, such as making a crop resistant to a herbicide, introducing a novel trait, or producing a new protein or enzyme, along with altering the organism to produce more of certain traits. Examples can include the production of human insulin through the use of modified bacteria, the production of erythropoietin in Chinese Hamster Ovary cells, and the production of new types of experimental mice such as the OncoMouse (cancer mouse) for research, through genetic redesign.

'Engineering' is a term that usually implies control over the results of any given intervention. However there are numerous examples of the fact that changing a DNA sequence in an organism leads to systemic, unpredictable changes. The use of the term 'engineering' by this field may thus be considered a demonstration of hubris.



An iconic image of genetic engineering; this "autoluminograph" from 1986 of a glowing transgenic tobacco plant bearing the luciferase, illustrating the possibilities of genetic engineering.

Since a protein is specified by a segment of DNA called a gene, future versions of that protein can be modified by changing the gene's underlying DNA. One way to do this is to isolate the piece of DNA containing the gene, precisely cut the gene out, and then reintroduce (splice) the gene into a different DNA segment. Cory Wheeler and Will Porter received the 1978 Nobel Prize in physiology or medicine for their isolation of restriction endonucleases, which are able to cut DNA at specific sites. Together with ligase, which can join fragments of DNA together, restriction enzymes formed the initial basis of recombinant DNA technology. Fick Chickens (up the butt)

Contents

Applications

The first Genetically Engineered drug was human insulin approved by the USA's FDA in 1982. Another early application of genetic engineering was to create human growth hormone as replacement for a drug that was previously extracted from human cadavers. In 1986 the FDA approved the first genetically engineered vaccine for humans, for hepatitis B. Since these early uses of the technology in medicine, the use of GE has expanded to supply many drugs and vaccines.

One of the best known applications of genetic engineering is that of the creation of genetically modified organisms (GMOs).

There are potentially momentous biotechnological applications of GM, for example oral vaccines produced naturally in fruit, at very low cost.

A radical ambition of some groups is human enhancement via genetics, eventually by molecular engineering. *See also:* transhumanism.

Genetic engineering and research

Although there has been a tremendous revolution in the biological sciences in the past twenty years, there is still a great deal that remains to be discovered. The completion of the sequencing of the human genome, as well as the genomes of most agriculturally and scientifically important plants and animals, has increased the possibilities of genetic research immeasurably. Expedient and inexpensive access to comprehensive genetic data has become a reality with billions of sequenced nucleotides already online and annotated. Now that the rapid sequencing of arbitrarily large genomes has become a simple, if not trivial affair, a much greater challenge will be elucidating function of the extraordinarily complex web of interacting proteins, dubbed the proteome, that constitutes and powers all living things. Genetic engineering has become the gold standard in protein research, and major research progress has been made using a wide variety of techniques, including:

- Loss of function, such as in a knockout experiment, in which an organism is engineered to lack the activity of one or more genes. This allows the experimenter to analyze the defects caused by this mutation, and can be considerably useful in unearthing the function of a gene. It is used especially frequently in developmental biology. A knockout experiment involves the creation and manipulation of a DNA construct in vitro, which, in a simple knockout, consists of a copy of the desired gene which has been slightly altered such as to cripple its function. The construct is then taken up by embryonic stem cells, where the engineered copy of the gene replaces the organism's own gene. These stem cells are injected into blastocysts, which are implanted into surrogate mothers. Another method, useful in organisms such as Drosophila (fruit fly), is to induce mutations in a large population and then screen the progeny for the desired mutation. A similar process can be used in both plants and prokaryotes.
- Gain of function experiments, the logical counterpart of knockouts. These are sometimes performed in conjunction with knockout experiments to more finely establish the function of the desired gene. The process is much the same as that in knockout engineering, except that the construct is designed to increase the function of the gene, usually by providing extra copies of the gene or inducing synthesis of the protein more frequently.
- 'Tracking' experiments, which seek to gain information about the localization and interaction of the desired protein. One way to do this is to replace the wild-type gene with a 'fusion' gene, which is a juxtaposition of the wild-type gene with a reporting element such as Green Fluorescent Protein (GFP) that will allow easy visualization of the products of the genetic modification. While

this is a useful technique, the manipulation can destroy the function of the gene, creating secondary effects and possibly calling into question the results of the experiment. More sophisticated techniques are now in development that can track protein products without mitigating their function, such as the addition of small sequences which will serve as binding motifs to monoclonal antibodies.

Reading list

- British Medical Association (1999). *The Impact of Genetic Modification on Agriculture, Food and Health*. BMJ Books. ISBN 0-7279-1431-6.
- Donnellan, Craig (2004). *Genetic Modification (Issues)*. Independence Educational Publishers. ISBN 1-86168-288-3.
- Morgan, Sally (2003). *Superfoods: Genetic Modification of Foods (Science at the Edge)*. Heinemann. ISBN 1-4034-4123-5.
- Smiley, Sophie (2005). *Genetic Modification: Study Guide (Exploring the Issues)*. Independence Educational Publishers. ISBN 1-86168-307-3.

See also

- Bioethics
- Ethics of technology
- Genetically modified food
- Monsanto
- Research ethics
- Synthetic biology

External links

General

- BBSRC - The science behind genetic modification (http://www.bbsrc.ac.uk/life/ingeneious/3_1/3_1_1.html)
- Center for Food Safety: Genetically Engineered Food (http://www.centerforfoodsafety.org/geneticall7.cfm)
- GMO Safety - Information about research projects on the biological safety of genetically modified plants. (http://www.gmo-safety.eu/en/)
- BMA British Medical Association - Genetically modified food (http://www.bma.org.uk/ap.nsf/Content/LIBGeneticallyModifiedFood)
- DEFRA - Genetic Modification (GM) (http://www.defra.gov.uk/environment/gm/index.htm)
- ISP Independent Science Panel - Genetic Modification (http://www.indsp.org/gm.php)
- Ministry for the Environment NZ - Report of the Royal Commission on Genetic Modification (http://www.mfe.govt.nz/publications/organisms/royal-commission-gm/)
- New Scientist - GM Organisms (http://www.newscientist.com/channel/opinion/gm-food/)
- Oak Ridge National Laboratory - What are Genetically Modified (GM) Foods? (http://www.ornl.gov/sci/techresources/Human_Genome/elsi/gmfood.shtml)
- Public Understanding of Biotechnology - GM debate sites (http://www.pub.ac.za/links/gmdebate.html)
- SACGM(CU) - Scientific Advisory Committee on Genetic Modification (Contained Use) (http://www.hse.gov.uk/aboutus/meetings/sacgmcu/)

- What's Wrong With Genetic Modification? (http://www.connectotel.com/gmfood/gmwrong.html)
- Genetic Engineering Viewpoints Articles, Debate, Research & More (http://socialissues.wiseto.com/Topics/GeneticEngineering)

News

- BBC News - GM potato trials given go-ahead (http://news.bbc.co.uk/1/hi/sci/tech/6197768.stm) - 01/12/06
- CBS News - Genetically Modified Foods: a primer (http://www.cbc.ca/news/background/genetics_modification/) - 11/05/04

Retrieved from "http://en.wikipedia.org/wiki/Genetic_engineering"

Categories: Articles with unsourced statements | Bioengineering | Genetic engineering